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Lubrication

A Technical Publication Devoted to the Selection and Use of Lubricants

THIS ISSUE

Cold Storage and Refrigeration Machinery Lubrication

PUBLISHED MONTHLY BY
THE TEXAS COMPANY, U.S.A.
TEXACO PETROLEUM PRODUCTS

TEXACO LUBRICANTS

For Ammonia and Carbon Dioxide Compressor Lubrication

	Temperature of Gas to Compressor		
	Above 20° F.	0° F. to 20° F.	Below 0° F.
For Horizontal Double-acting Machines where Oil is delivered to Piston Rod and Compressor Cylinder	**TEXACO CETUS OIL**	**TEXACO CAPELLA OIL**	**TEXACO SPICA OIL**
For Enclosed Type Vertical Compressors (Splash or Pressure Lubricated)	**TEXACO ALCAID OIL**	**TEXACO CETUS OIL**	**TEXACO CAPELLA OIL**

NOTE: Where separator is comparatively small or located adjacent to compressor, to result in relatively slow separation, use an oil of somewhat higher viscosity.

Order of viscosity (from low to high) of the above oils is Texaco Spica Oil, Texaco Capella Oil, Texaco Cetus Oil, Texaco Alcaid Oil.

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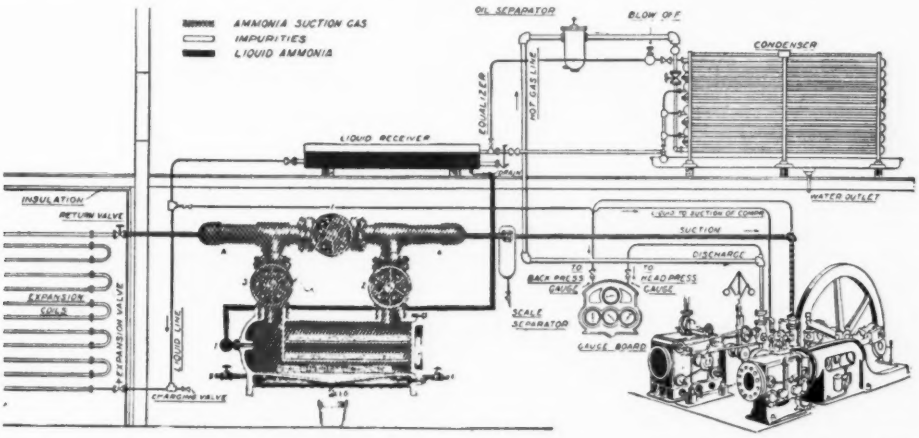


Courtesy of De La Vergne Machine Co.

Fig. 1—General arrangement of an ammonia refrigerating plant showing essential parts, a horizontal compressor and flow of refrigerant.

Cold Storage and Refrigeration Machinery Lubrication

ICE making and the direct or indirect cooling of air or cold storage compartments by means of certain chemicals having refrigerating properties is one of the essential industries of modern civilization. In the preservation of food-stuffs alone it is, in fact, so vital to our livelihood that it would be practically impossible to revert to the mode of living of fifty years ago. The congestion of population alone would prevent this, for food-stuffs can no longer be raised by even the farmer to satisfy his entire needs.

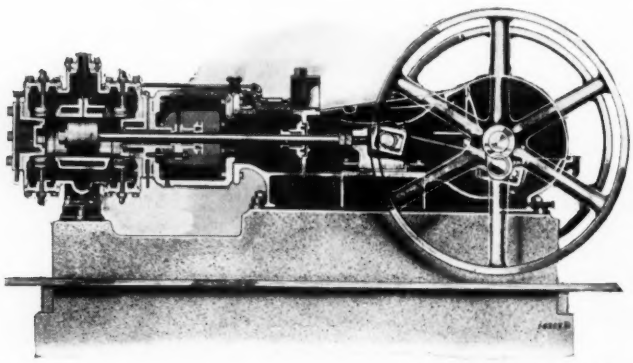
The age of independence in this regard is as much a matter of the past as is the age of home-manufactured clothing. Mankind has simply outgrown the ability to exist without teamwork.

Cold storage and refrigeration spell teamwork to the highest degree. The preparation, transportation and storage of meats, fruits, dairy and poultry products would be impossible without it, even with express freight service.

Refrigeration, as the more accepted general term applied to this industry, includes both the manufacture of ice and the cooling of air in cold storage systems. The former, involving water as it does, presents the possibility of dampness, and where ice is allowed to melt, the matter of sanitation and water removal. The

latter, on the other hand, is relatively dry, with little or no moisture involved.

Cold Storage, in turn, can be direct or indirect. In the former the refrigerant is used directly to cool the storage compartment or tanks by expanding it in suitable coils located therein. Indirect refrigeration involves preliminary cooling of air or brine by circulation over expansion coils containing the refrigerant, in a separate compartment or bunker room, or otherwise subjecting it to the cooling reactions of ammonia, or whatever product is used, by means of suitable coils, etc. This cooled air or brine is then passed to the storage compartments, refrigerating rooms or boxes.



Courtesy of Ingersoll-Rand Co.

Fig. 2—Cut-away view of a horizontal compressor showing relation of wearing elements, and the mechanical force feed lubricator for cylinder and stuffing box lubrication.

REFRIGERATING MEDIUMS

Commercial refrigeration is based upon two phenomenae: (1) Evaporation and expansion of the refrigerant, whereby heat is absorbed from the surroundings, and (2) Compression and condensation, whereby this heat is in turn abstracted from the refrigerant and the latter again changed to liquid form.

For this purpose a number of chemicals are in commercial use today as refrigerants. Anhydrous ammonia (NH_3) or ammonia free from water, is most commonly used. Under normal conditions this chemical occurs as a gas, but by either or both decreasing the temperature and increasing the pressure it may be readily liquefied. Other chemicals which are employed to a certain lesser extent are carbon dioxide, ethyl and methyl chlorides, sulphur dioxide, and certain hydrocarbons, such as ethane, propane, iso-butane and butane.

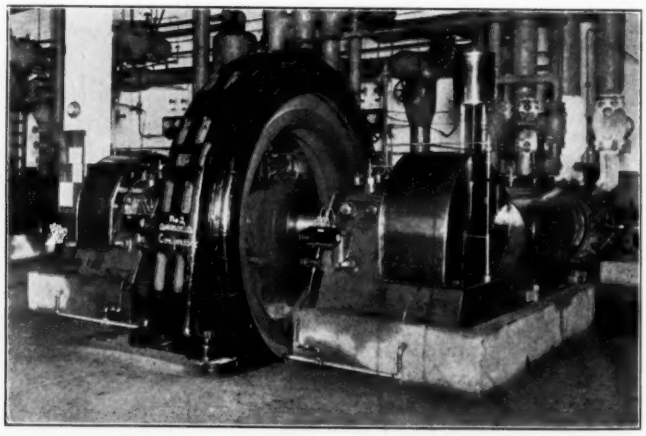
Ammonia

In the application of ammonia to refrigeration purposes, it can be handled by either one of two methods, i. e., by wet or by dry compression.

Wet compression is attained either by the introduction of liquid ammonia directly into the compressor cylinder at the beginning of the compression stroke, or, by operating so that somewhat more liquid ammonia than can be evaporated is passed into the refrigerator coils. Subsequently this liquid returns to the compressor with the balance of the refrigerant which has been vaporized, and is itself evaporated on the suction stroke by the heat of the compressor. Its presence serves to effectively decrease compression temperatures, and increase the volumetric efficiency.

In a wet compression system, however, the operator can never be certain that the excess liquid has become vaporized at the end of the suction stroke, regardless of the attention given to the machine.

Dry compression constitutes the passing of ammonia vapor alone into the compressor. It involves the same operating principles as wet compression with the exception that discharge temperatures are somewhat higher.



Courtesy of McCord Radiator & Mfg. Co.

Fig. 3—External view of a horizontal ammonia compressor installation showing mechanical force feed lubricators, and the tank and piping of the gravity circulating system which serves the external wearing elements.

Carbonic Anhydride

Carbonic Anhydride (CO_2) refrigeration involves an arrangement of machinery and equipment much similar to an ammonia compression system. In fact the essential difference (other than in regard to certain details of con-

struction in view of the higher pressures involved) is in the cooling medium or refrigerant employed. Carbonic anhydride or carbon dioxide, as it is more commonly termed, is non-explosive, odorless, non-combustible, a fire-extinguisher, and neutral in its action upon food-stuffs, fabrics and other substances which may require cold storage. Normal leakage is, therefore, not generally harmful even though it may be more prevalent due to the higher pressures involved.

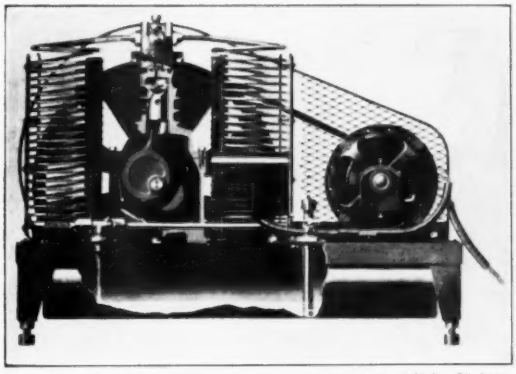
Carbonic anhydride systems include both horizontal and vertical compressors according to the type of service and refrigerating capacity involved. Single and double acting compressors are in use, but due to the difficulty in maintaining tight stuffing boxes, the single acting machine is often preferred. Frequently pressures as high as 1,000 pounds or more may be necessary; therefore, it is evident that the system must be of exceptional rigidity.

Ethyl Chloride and Methyl Chloride

Ethyl and methyl chlorides are comparatively stable, non-poisonous, slightly inflammable chemicals, readily subject to low working pressures. They are practically neutral, chemically, and have no appreciable effect on the usual metals employed in machine construction.

Hydrocarbons Such as Ethane, Butane, etc.

Hydrocarbon refrigerants are used to some extent, especially for household and retail business purposes. These chemicals have a distinct



Courtesy of Delco-Light Co.

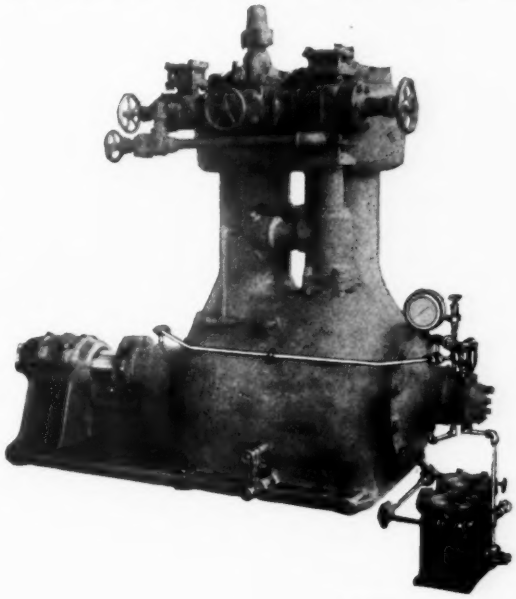
Fig. 4—Cut-away view of a Frigidaire Air Cooled compression unit which uses sulphur-dioxide as the refrigerant. The compressor is splash lubricated, oil which may work past the piston being returned to the base after accumulation in the header during the compression cycle.

property in that lower temperatures are made possible by their application.

Products, such as ethane, butane, etc., are non-corrosive, chemically neutral towards water, relatively stable, under ordinary conditions, non-poisonous, and can be handled in the same equipment as is required for ammonia. They are, however, inflammable in the presence of open flames.

Sulphur Dioxide

Many smaller refrigerating systems are designed to use sulphur dioxide as the refrigerating medium. As a liquid, sulphur dioxide is colorless but has a strong odor and can be readily detected. It is soluble in water, in which solution it is strongly acidic. While poisonous, it is not usually regarded as dangerous when employed for refrigeration purposes, due to its penetrating odor which serves as a warning of its presence.



Courtesy of York Mfg. Co.

Fig. 5—Side view of an ammonia compressor showing external details of the lubricating system. Combination splash and pressure feed is involved. Note the oil strainers, piping to main bearings and stuffing box, and oil pressure gauge.

METHODS OF REFRIGERATION

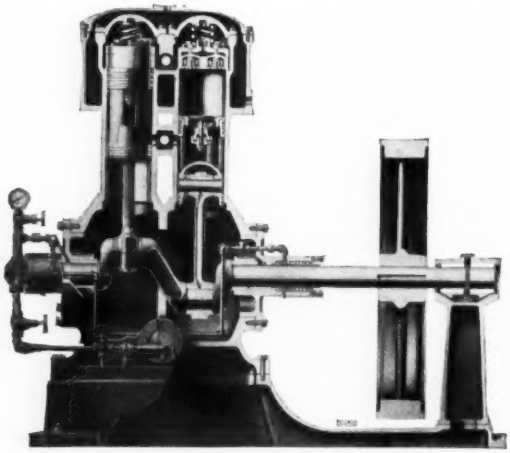
While there are a number of various types of refrigerating machines in more or less common use, they all can be definitely grouped into two distinct classifications, according to the methods involved, i. e.: (1) Where refrigeration is produced by the evaporation of some volatile liquid. (2) Where refrigeration is effected by the compression, cooling and expansion of air.

The first classification can be subdivided into three groups, according to whether the principles of (a) compression, (b) absorption, or (c) vacuum, are employed.

Compression Systems

The compression process is chiefly used today. Essentially a compression system in-

cludes a compressor, oil separator, condenser, expansion valve, and an evaporator or refrigerator. Compressors may be either single or double acting according to the size of the installation and extent of refrigeration required. In the compression process the refrigerant or



Courtesy of Frick Co., Inc.

Fig. 6—Cut-away view of an enclosed vertical compressor. This machine is pressure lubricated, the essential details of bearing, cylinder and stuffing box lubrication being clearly shown.

cooling agent is recovered after each expansion by means of mechanical compression. With certain variations in construction and arrangement of equipment, the compression process is adaptable to such refrigerating agents as ammonia, carbonic anhydride, methyl chloride, sulphur dioxide and certain hydrocarbons, etc.

In operation, the gaseous refrigerant in a compression system must be sufficiently compressed and cooled to convert it to liquid form. Under compression alone it will still remain as a gas, due to the fact that the application of pressure raises the temperature above the liquefaction point. Some form of condenser must therefore be used.

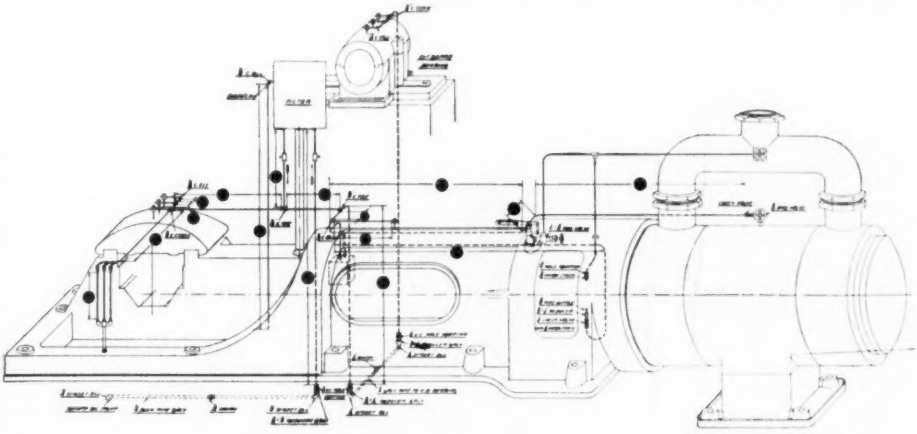
Prior to condensation, however, the gas is usually passed through a suitable oil separator or trap in order to free it of any excess lubricant that may have gained entry into the compressor. From the oil separator the hot refrigerant then passes to the cooling coils of the condenser where its temperature is sufficiently lowered by means of air or cold circulating water, to convert it to liquid form. It is then capable of serving as a cooling medium. This is brought about by passing it through an expansion or regulating valve to the expansion side of the system. Here by virtue of a considerable drop in pressure it evaporates and takes up heat, returning thereafter to gaseous state once more. In so doing it cools down to a relatively low temperature and as a result absorbs heat from the surroundings, whatever these may be. It is then returned to the compressor to commence this cycle of operation anew.

Refrigeration by Absorption

The absorption process makes use of the fact that certain low-boiling-point vapors are readily absorbed by water, being capable of subsequent separation by fractional distillation upon the application of heat.

Ammonia is principally used in absorption refrigeration due to its relatively high affinity for water and the readiness with which it can be distilled off under pressure and temperature conditions where water is unaffected. The latter is, therefore, able to remain in a liquid state.

Absorption refrigeration involves three stages or sets of equipment, whereby the ammonia is first distilled in a suitable steam heated generator, freed from any water vapor in an analyzer, and liquefied by passage through a suitable condenser. It is then ready for the second, or refrigeration stage, being passed to an evaporator or set of cooling coils. The third stage usually comprises the passing of the gaseous ammonia under its own pressure to an absorber, where it is taken up by a weak



Courtesy of The Vilter Mfg. Co.

Fig. 7—Oiling arrangement for a high speed ammonia compressor, showing essential piping and fittings.

ammonia solution. When suitable concentration of the latter has been attained it is pumped back to the generator, and the cycle begun anew.

Absorption refrigeration involves pumps instead of compressors, one working below atmospheric pressure, the other above.

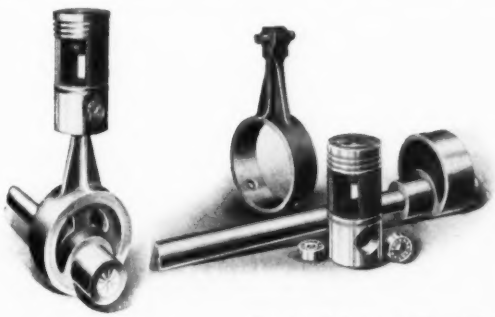
IMPORTANCE OF LUBRICATION

Refrigerating machine lubrication is an important factor. Oil in any part of a cooling system will tend to reduce refrigerating efficiency due to its becoming so sluggish under the low temperatures involved as to form an interior lining in the expansion coils and materially effect the heat transfer.

Lubrication of refrigerating machinery is exceptional in that we must consider the action and effects of the lubricants upon parts not requiring lubrication, as well as upon the actual wearing surfaces. As a result, considerable care and judgment must be used in selecting the lubricants.

SYSTEMS OF LUBRICATION

Splash and pressure lubrication predominate in refrigerating compressors today. The latter is suited for the lubrication of both vertical and horizontal machines. The former, however, is more adapted to the vertical compressor. The system involved for the lubrication of compressor cylinders, stuffing boxes and enclosed bearings will have a decided influence upon the grade of the oil that should be used. It will, therefore, be of interest to study the



Courtesy of Brunswick-Kroeschell Co.

Fig. 8—Details of the Brunswick eccentric drive for vertical ammonia and carbon dioxide compressors. Note in particular the ball bearing wrist-pin, which materially reduces power consumption, facilitates lubrication and renders possible the replacement of any individual parts without disturbing the others.

principles involved in the afore-mentioned methods of lubrication.

Splash Lubrication

Splash lubrication constitutes distribution of the oil at each revolution of the crank, the level in the crank-case being maintained just high enough to permit the crank to dip and splash the necessary amount of oil to the cylinder walls, etc. Continued operation will result in the crank-case being filled with a lubricating vapor above the main body of oil which will

Courtesy of The Automatic Refrigerating Co., Inc.

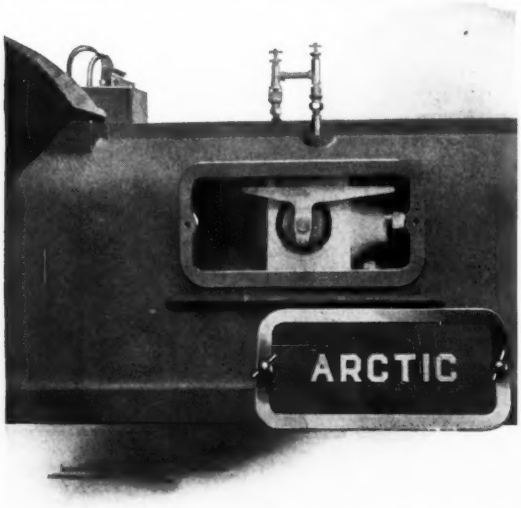
Fig. 9—End view of a vertical ammonia compressor showing the automatic oil pump and connections. The compressor itself is splash lubricated.

insure adequate lubrication of main, wrist pin and crank pin bearings as well. Careful attention is necessary, especially when re-charging the case with oil, to see that the level is not raised too high. The result would be churning by the crank, bringing about such violent agitation in the main body of oil as to oftentimes preclude effective precipitation of any impurities that may have gained entry. There would also be possibility of loss of lubricant past the piston rings, with subsequent entry of an excess of oil into the condensing and evaporating parts of the system.

Another point to remember in this regard is that where piston rings are not sufficiently tight, if the crank-case contains too much oil or agitation is too violent, the excess which naturally will reach the cylinder walls will tend to work past the rings, just as occurs so frequently in an automobile engine. This is often termed oil pumping. Not only is it wasteful, but especially in an ammonia compression system will it be a detriment, for oil in the refrigerating lines will impose an added load on the oil separator. Furthermore, if by chance the oil is not of sufficiently low pour test there will be possibility of its congealment within the system, reducing refrigeration to a marked degree.

Use of excess oil in a splash lubricated system will also involve the possibility of difficulty when draining and cleaning, especially where sludging has taken place. Churning of many oils will give rise to sludge formation if they have not been very highly refined. In part this

is due to oxidation, and it will be more apt to occur if water is present or the oil is laden with very much foreign matter such as dirt, metallic particles or carbon. It is therefore important to



Courtesy of *The Arctic Ice Machine Co.*

Fig. 10—Guide section and crosshead view of a horizontal ammonia compressor, with cover plate removed to show oil catch.

observe regular periods for cleaning and to look carefully into the condition of the used oil for this will very often indicate both the approximate suitability of the latter and the extent to which effective lubrication is being attained.

Pressure Lubrication

In many vertical and horizontal refrigerating machines, especially on larger types, pressure lubrication is used with marked success. More accurate control of the amount of oil delivered to cylinder walls and compressor bearings is possible with such a system. On the other hand it requires more equipment, piping, etc., and entails frequent filling of reservoir and more attention from the operator, than where splash lubrication is involved.

One of the chief advantages of pressure lubrication, however, is the possibility of effective filtration or purification of the oil if it is to be re-circulated. With a splash oiling system this can only be done whenever the crankcase is drained.

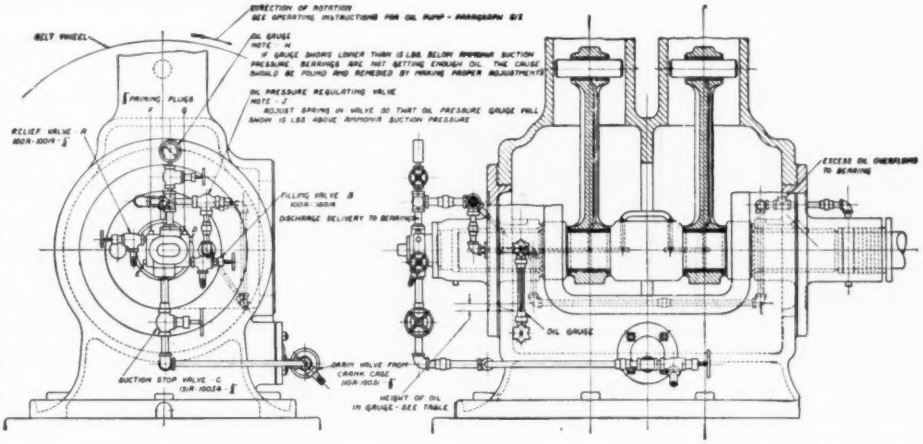
Mechanical force feed lubricators are extensively used where compressor cylinders are to be pressure oiled. Excellent economy will be attained by regulating such lubricators so that just enough oil is delivered to maintain the requisite lubricating films, with the least amount of excess to drain off.

On many types of machines it is good practice to lubricate internal and external parts individually. In other words, using the mechanical lubricator with perhaps three outlets for cylinder and stuffing box service, and an independent gravity or mechanical pressure circulating system for all external bearings.

For these latter a high grade engine or machine oil will suffice. Low pour test or exacting flash point requirements for this type of work are relatively immaterial; it is only essential that the viscosity be sufficient to carry bearing loads, and that the oil is conducive to ready separation from foreign matter and impurities.

Mechanical force feed lubricators are also adaptable to cylinder lubrication via the oil lantern, or oil recess within the piston rod stuffing box. By so constructing a stuffing box it is possible to operate the piston rod continually through a ring of oil. In this way effective rod lubrication as well as sealing against pressure are maintained.

To lubricate the cylinder in addition it is only necessary to deliver a certain excess of oil to the stuffing box lantern and provide a so-called



Courtesy of *Frick Co., Inc.*

Fig. 11—Details of Force-feed oiling system in a vertical, enclosed type compressor.

overflow pipe to carry this to the refrigerant suction line adjacent to the cylinder.

In effect this is similar to the principles of steam cylinder lubrication, the refrigerating gas

being impregnated with vaporized lubricant prior to its passage through the compressor. Hand pump oilers can also be used for this purpose, but mechanical force feed lubricators are more positive and require less attention.

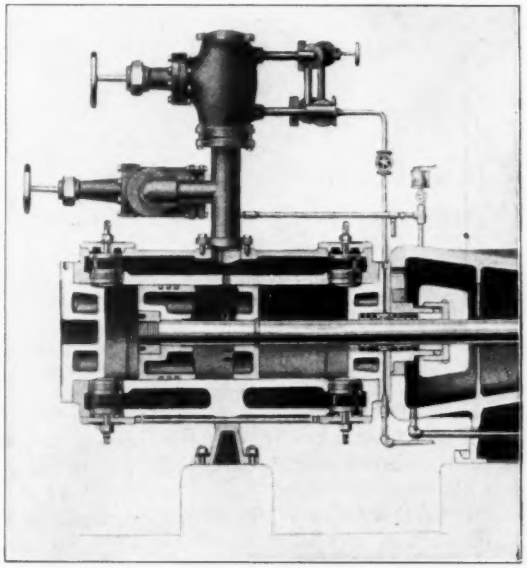
SELECTION OF AMMONIA COMPRESSOR LUBRICANTS

Lubricants for cold storage and refrigeration machinery must always be selected with due regard for the service involved and the operating conditions that will probably be encountered. To overlook or disregard the importance of such factors as the method of lubrication involved, the temperature in the expansion or refrigerating coils, the mechanical condition of the compressor, etc., and the location, type and efficiency of the oil separator may frequently lead to marked increase in maintenance costs and reduction in capacity.

Lubricating oils for service in an ammonia compression system, therefore require consideration of their pour test, fire point and viscosity for it is these characteristics which will be indicative of the extent and degree of success with which any lubricant will function, in accordance with the particular operating and constructional conditions involved.

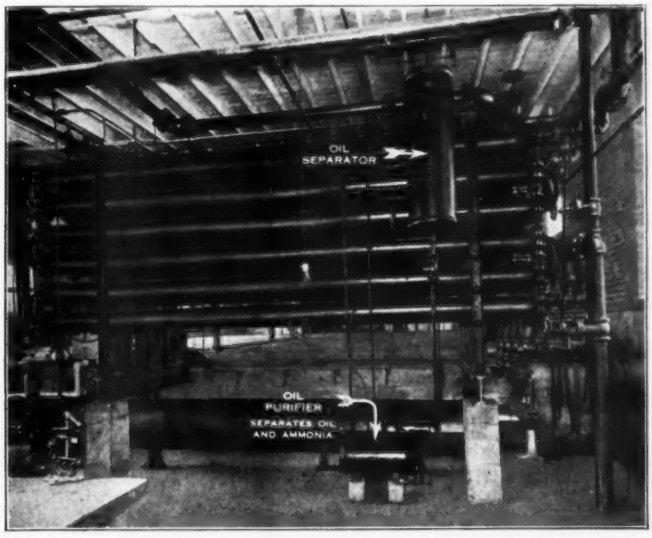
Importance of the Pour Test

Perhaps the most important essential in regard to an oil for refrigerating machinery lubrication is that it shall remain fluid at the lowest temperatures to which it may be subjected during operation. These temperatures will be encountered in the expansion or refrigerating side of the system, or in other words, beyond the expansion valve. There are many oils, of course, which by virtue of their base and degree of refinement will not be able to withstand lower temperatures without congealing to a certain extent, depending upon the amount of wax that may be contained.



Courtesy of De La Vergne Machine Co.

Fig. 13—Cut-away view of a horizontal compressor cylinder showing oil piping to gas intake, and stuffing box "oil lantern," also details of construction of this latter.



Courtesy of Henry Vogt Machine Co., Inc.

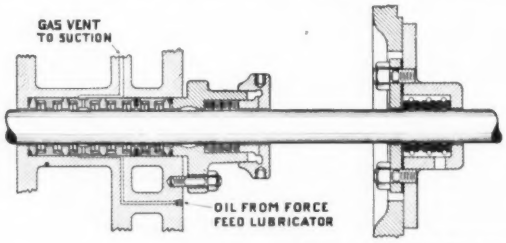
Fig. 12—View of a refrigerating plant condenser with oil separator and purifier shown in relative position.

Congealment, of course, will mean that a film of oil will be deposited on the inner surfaces of the refrigerating piping, to form more or less of an insulating medium which will prevent proper abstraction of heat from the compartment or medium which is to be cooled. If this is allowed to continue it is evident that the refrigerating capacity of the system will be reduced and ultimately it will be necessary to clean out these congealed oil deposits.

Flash Point Also a Factor

Low pour test is not the only important characteristic. It is also essential at the same time that the oil have a high enough flash point at the pressure involved to insure against being carried over too rapidly at the discharge temperature. Flash point, in a wet compression system, is of less concern, inasmuch as discharge temperatures are usually considerably below those encountered in dry compression, and in both cases, below the flash point of the usually accepted ammonia compressor oil.

An oil to be suited to this class of service should have a pour test sufficiently low to insure continued fluidity at the lowest temperatures prevalent in the evaporating side of the system. It should not congeal on the inner surface of the cooling coil, and there should be sufficient viscosity throughout the range of operating



Courtesy of Ingersoll-Rand Co.

Fig. 14—Details of construction of metallic packing for an ammonia compressor.

temperatures to enable it to serve at all times as an effective lubricant for the moving parts as well as an adequate seal for the piston rings and compressor valves.

For such service a straight mineral filtered oil having a viscosity of about 100 seconds Saybolt at 100 degrees F. will be necessary where the temperature of the gas to the compressor is below 0° F. Above this temperature, however, an oil of somewhat higher viscosity, i. e., 200 to 300 seconds Saybolt, will give more satisfactory results.

The purest grade of straight distilled mineral oil obtainable is always advisable in order that the above requirements will be adequately met. Oils of this nature will have a sufficient range of physical properties to lubricate compressors effectively under all normal operating conditions.

Mineral oils are more suitable than compounded lubricants inasmuch as animal and vegetable oils will not only have a tendency to congeal at low temperatures and gum at higher temperatures, but will also react to a certain extent with ammonia. In addition they may tend to cause the formation of sludge by reaction with ammonia gas.

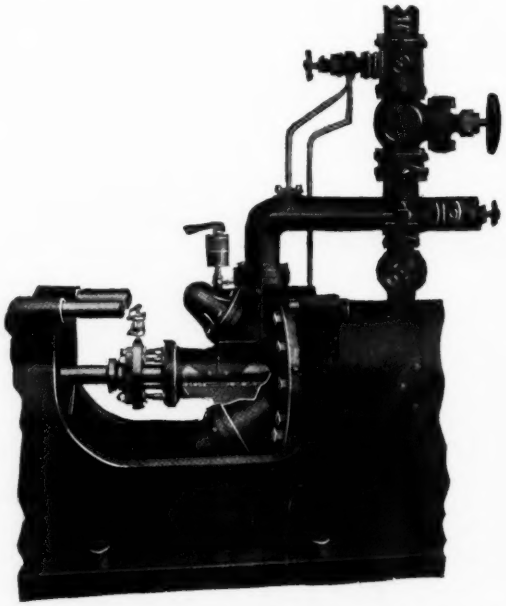
Water an Objection

Relative to this matter of possible congealment, consideration must also be given to water. It is essential that the oil at all times be practically free from water, otherwise this will freeze if carried over to the refrigerator coils, in which case it would probably remain in the system and result in a certain decrease in evaporative efficiency. It is therefore necessary for the operator to use the utmost care in placing oil cans beneath snow-covered suction pipes, etc., or anywhere else where moisture might splash or drip into the contents. An excess of water can readily cause so much trouble in the evaporator coils as to necessitate shut down of the plant until this is corrected.

Relation of Viscosity

When enclosed crank-case, high speed machines of the wet compression type are involved, higher viscosity oils should be used which will stand considerable churning in the presence of the refrigerant and a certain amount of water vapor. To some extent the emulsions which may result will serve as lubrication for the cylinder wall, due to their adhesive nature. In excess, however, they will accumulate in the crank-case and tend to pass by the piston rings and into the system, where clogging may ultimately occur.

The physical condition of the valves, piston rings and stuffing boxes, must always be considered in deciding upon the viscosity of oil to use. Practically as important as its lubricating properties will be the seal and compression-forming ability. If the cylinder wall and moving parts are in first-class condition, a straight mineral oil of approximately 200 to 300 seconds



Courtesy of The Triumph Ice Machine Co.

Fig. 15—A compressor stuffing box arrangement which illustrates the principles of compressor lubrication by means of an "oil lantern."

Saybolt viscosity at 100 degrees F. will be suitable.

The more worn and scored the cylinder walls and rings, naturally the higher must be the viscosity (within practical limits) to maintain the requisite seal and degree of compression. Usually an oil having a viscosity of 300 seconds

Saybolt at 100 degrees F. will be satisfactory in this event.

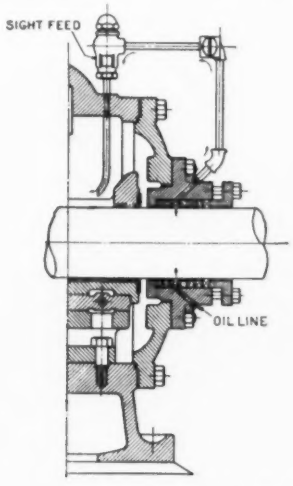
Horizontal compressor cylinders will have a greater tendency to wear out of round than those of vertical machines, due to the weight of the piston which must be carried on the under wall. Therefore such compressors will in general require a somewhat heavier lubricant. It is not advisable, however, to attempt to compensate for wear by increasing the viscosity too much, due to the possibility of emulsification, and contamination of the refrigerant as mentioned above.

CONTROL OF OIL SUPPLY

The detriments due to an excess of oil finding its way to the evaporating or cooling side of a refrigerating system have already been mentioned. In this connection it is interesting to discuss the means whereby it is normally prevented, i. e., by use of an oil separator.

Function of the Separator

Any excessive lubricant fed to the compressor will tend to impose a heavy load upon the oil separator. The actual function of the oil separator is to remove any particles of oil from the refrigerant while it is in gaseous form, after it has left the compressor. The larger the oil particles of course the more effective will be the



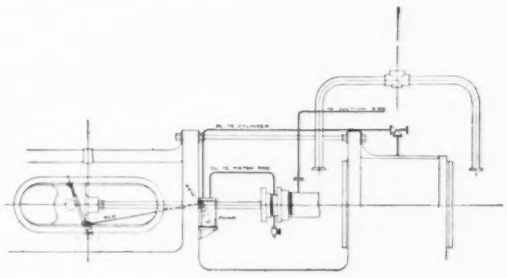
Courtesy of York Mfg. Co.

Fig. 16—Sectional view of a stuffing box with semi-metallic packing. Construction of the "oil lantern" enables passage of a continuous stream of oil to insure ample lubrication and effective sealing against gas leakage.

separator. Therefore it should be located at a sufficient distance away from the compressor to permit of adequate precipitation, so to speak, of the oil within the ammonia gas. The capacity of any separator should be ample so that the velocity of the gas passing through will not be too high.

Location of the Oil Separator

Location of the oil separator or trap is decidedly important. It should be placed between the discharge of the compressor and where the gas enters the condenser. In certain machines a purge valve may be installed under the condenser to enable removal of any oil



Courtesy of The Vilter Mfg. Co.

Fig. 17—Arrangement of oil piping to a compressor cylinder and piston rod showing mechanical force-feed lubricator and its driving connection.

that may have passed the separator. Where the oil separator fails to function properly, the reason is often because it is set too near the compressor and the rush of hot gas prevents proper oil condensation.

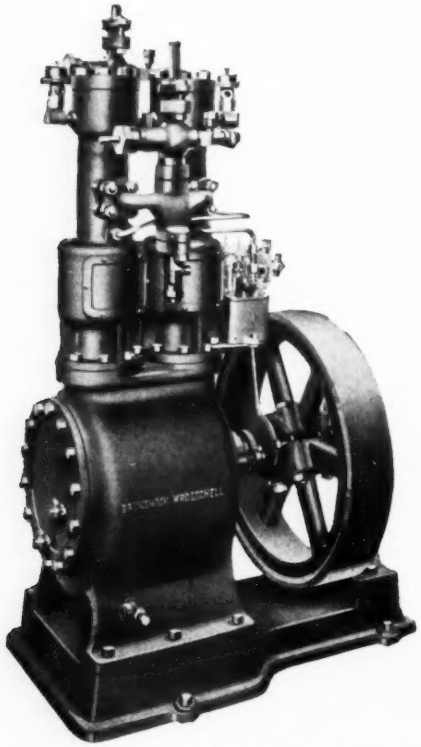
Atomization of the lubricant will practically always take place to a certain extent by virtue of the heat of compression which is prevalent, regardless of how high the flash point may be. This oil vapor will, therefore, tend to pass into the system with the refrigerant to condense and remain in the colder parts unless it is effectively removed before it enters the condenser.

In consequence the separator should be located as close to the condenser and as far away from the compressor as possible. It is always advisable that it should be of sufficient size to allow of ample reduction in the velocity of the gas in order to permit of effective separation. A smaller separator located some distance from the compressor may often prove more effective than a large separator located nearby.

Of course, where it is impossible to locate the main oil separator elsewhere than adjacent to the compressor, it is well to use an oil of as low an atomizing tendency as possible. Usually low atomization accompanies high viscosity, the choice of the heavier oil would, therefore, solve the problem to some extent. In general a viscosity of about 200 seconds Saybolt at 100 degrees F. will meet these conditions satisfactorily.

The efficiency of an oil separator can be readily checked by comparing the amount of oil removed from it with the amount fed to the compressor. Any extensive difference would indicate that the oil is not being entirely removed or trapped. Allowance, of course, should be made for oil leakage around the stuffing box

although to just what extent this may occur will depend on the individual installation, the viscosity of the oil, and the care given to lubrication



Courtesy of Brunswick-Kroeschell Co

Fig. 18—A vertical, two-cylinder carbon dioxide compressor of the single acting type. Bearings are splash lubricated, the cylinders and stuffing boxes being pressure oiled by a Hills-McCanna force-feed lubricator. This compressor is equipped with the eccentric drive and ball-bearing wrist pin shown in Fig. 8.

RECLAIMING OF OIL

Compressor oil can be reclaimed by installing an ammonia distilling apparatus which has the dual advantage of purifying the charge of ammonia to keep same in a pure anhydrous condition (without interfering with the continuous operation of the plant), and also recovering the lubricating oil.

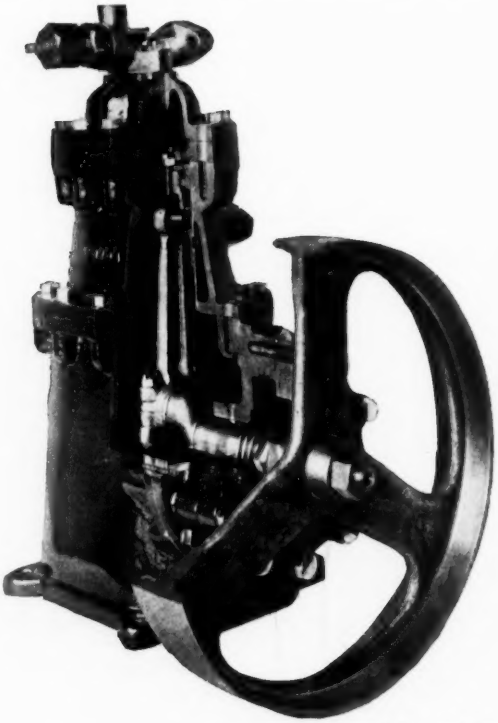
These ammonia stills are connected to the oil separator in the discharge line and the bottom of the liquid ammonia receiver from which oil and other impurities may be drawn, for subsequent distillation of ammonia.

After all the liquid ammonia has been evaporated and returned to the suction line of the system the oil can then be drawn from the bottom of the still, using suction pressure for this purpose. Such oil as is drawn off will contain a certain amount of gas. It should therefore be set aside until the gases have freed themselves. The application of a little heat will assist this operation materially.

The oil is then ready to be filtered. It is advisable to use a separate filter for this work. The size and type of filter to be used will depend upon the size of the plant and the amount of oil to be handled. Providing the original oil used on compressors is of good quality and properly selected, the oil recovered from the distiller after careful filtration can again be used for lubrication of the compressors.

In many plants such oil as is recovered is, however, used for external lubrication, and only new oil is employed for the lubrication of the ammonia compressors. This is safe practice and an assurance that the oil used on the compressors is perfectly clean and up to specifications.

Operation of these ammonia distillers is so simple and well known to engineers in refrigerating work that it will not be necessary to go into details exhaustively. Care should of course be taken in handling the distiller to prevent too rapid evaporation, which will cause a boiling-over effect and the loss of a large proportion of oil through passage back to the suction line.



Courtesy of The Servel Corp.

Fig. 19—Cut-away view of a vertical, reciprocating methyl chloride compressor designed for domestic service. Splash lubrication is employed, the oil being carried in the base.

STUFFING BOX SEALS

In ammonia and carbonic anhydride refrigeration practice one of the most important factors is to maintain suitable stuffing box seals

and properly lubricated piston rods. It is necessary to remember that ammonia has a certain corrosive action upon copper and bronze. Therefore, stuffing boxes are usually built of cast iron or steel (as are other parts of the compressor) and metallic (babbitt metal), asbestos, or rubber packing is used.

Function of the Oil Lantern

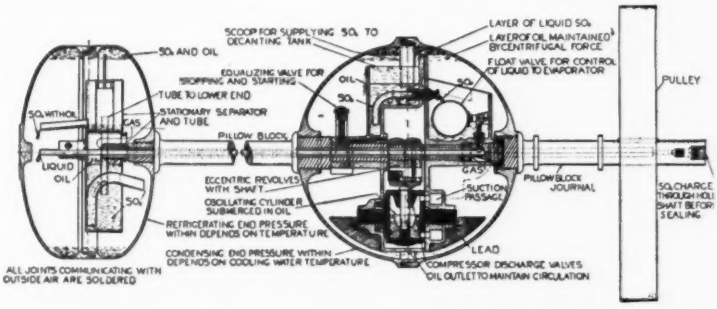
To lubricate the piston rod effectively in some types of machines a hollow space or "oil lantern" is located between two separate sets of packing. This space surrounds the rod and is filled with oil. It also serves as a seal to prevent loss or leakage of ammonia.

The lubricant is usually fed to the "oil lantern" by means of a hand or automatic pressure oil pump. Where the piston rod is efficiently lubricated, its surface will have a smooth gloss, and will be covered with a light film of oil; there will be no indication of overheating and a relatively perfect seal will be maintained with a minimum of leakage.

In some types of double-acting machines, the "oil lantern" serves also as a means of introducing the lubricant to the compressor cylinder by allowing it to work past the piston rod packing. There is an added advantage to this method in that certain grades of packing which might be reacted upon by ammonia gas will be protected by the lubricant.

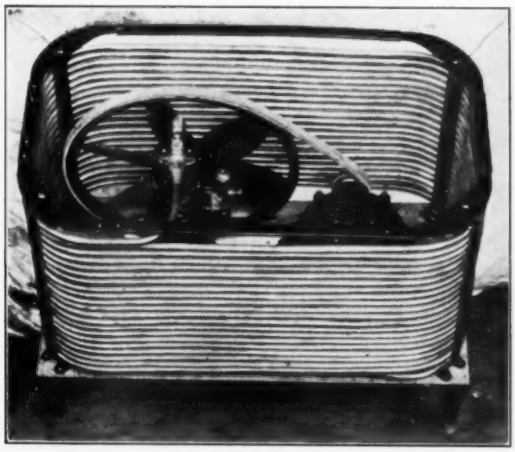
More usual practice, however, is to design compressors for pressure lubrication, and install a positive force feed lubricator which is driven from the reciprocating mechanism through suitable connecting links. Force-feed lubrication is advantageous in that the amount of lubricant supplied to the compressor is dependent upon the speed of operation. Thus, by careful adjustment and correction it is possible to feed a definite quantity of lubricant at each stroke and at just the right time to be most effective.

Force-feed lubrication is, therefore, dependable, economical and requisite of little attention on the part of the engineer, excepting when it is necessary to refill the lubricator.


SCOOP FOR SUPPLYING SO₂ TO DECANTING TANK
LAYER OF LIQUID SO₂
LAYER OF OIL MAINTAINED BY CENTRIFUGAL FORCE
FLOAT VALVE FOR CONTROL OF LIQUID TO EVAPORATOR
PULLEY
SO₂ AND OIL
EQUALIZING VALVE FOR STOPPING AND STARTING
TUBE TO LOWER END
SO₂ WITH OIL
GAS
STATIONARY SEPARATOR AND TUBE
PILLOW BLOCK
LIQUID OIL
SO₂
ECCENTRIC REVOLVES WITH SHAFT
OSCILLATING CYLINDER SUBMERGED IN OIL
GAS
SUCTION PASSAGE
PILLOW BLOCK JOURNAL
SO₂ CHARGE THROUGH HOLLOW SHAFT BEFORE SEALING
REFRIGERATING END PRESSURE WITHIN DEPENDS ON TEMPERATURE
CONDENSING END PRESSURE WITHIN DEPENDS ON COOLING WATER TEMPERATURE
LEAD
ALL JOINTS COMMUNICATING WITH OUTSIDE AIR ARE SOLDERED
COMPRESSOR DISCHARGE VALVES
OIL OUTLET TO MAINTAIN CIRCULATION

Courtesy of Audiffren Refrigerating Machine Co.

Fig. 21—A dumb-bell type of sulphur dioxide machine. Details of construction are clearly indicated. The oil for such a machine must be a medium viscosity, specially refined petroleum product so prepared as to have no reaction with sulphur dioxide.



Courtesy of Kelvinator Corp.

Fig. 20—Top angle view of a sulphur dioxide compression unit showing compressor, driving motor, connecting belt and air cooling coils. Note arrangement of the latter. This compressor is also splash lubricated; it being of the vertical, enclosed reciprocating type.

ABSORPTION SYSTEMS

Perhaps the simplest of any refrigerating systems from the viewpoint of lubrication is the ammonia absorption system. Here the lubrication of such pumps as are employed involves comparatively little difficulty. As a rule an oil of from 200 to 300 seconds Saybolt viscosity at 100 degrees F. will serve to lubricate external bearings effectively.

LUBRICATION OF CARBONIC ANHYDRIDE COMPRESSORS

From an operating and constructional point of view there is a decided similarity between both ammonia and carbonic anhydride compressors. The marked difference in pressures, however, often requires separate consideration in regard to lubrication. The lubricant of course should be a straight mineral oil having essentially the same characteristics as for a dry ammonia compression system, such as low pour test, a flash point sufficiently above the discharge temperature to insure against excessive vaporization, and a viscosity in the neighborhood of 100 to 300 seconds Saybolt at 100 de-

grees F., dependent upon operating conditions and the design of the system.

Carbonic anhydride compressor cylinder temperatures are usually somewhat higher than ammonia compressor temperatures due to the higher pressures involved.

It is interesting to know that mineral oil has no affinity for carbon dioxide, hence there is little or no possibility of its being carried over into the condenser unless it is vaporized, which is not likely to occur when the right oil is used.

To insure against any oil whatsoever passing over into the system, an oil trap is usually installed in the discharge line from the compressor. Stuffing boxes are built similar to those on a double-acting ammonia compressor, with the exception that the higher pressures involved require more compartments.

Force-feed lubrication is the usual means provided for serving the piston rod and maintaining an adequate stuffing box seal. The same lubricator usually serves the compressor valves and piston as well. The feeding of a suitable amount of lubricant to the stuffing box prevents loss of gas.

The lubricator must be very carefully adjusted at all times, however, the same as for an ammonia machine, since the feeding of an excessive supply of oil will often result in a certain amount of it passing to the gas relief line and thence into the system.

ETHYL AND METHYL CHLORIDE SYSTEMS

Lubrication of ethyl and methyl chloride compressors can be carried out either with highly refined mineral oils or with chemically pure glycerine or ethylene glycol. The former afford effective lubrication provided they are kept out of contact with the refrigerants when the latter are in liquid form. Where such contact occurs more or less solution will result. There is but little probability of this happening, however, if the compressors are properly designed and constructed. In vaporous state these refrigerants have but a slight tendency to reaction with petroleum products.

Glycerine and glycol are practically insoluble in both ethyl and methyl chlorides when these are in liquid form, therefore, they can be used with perhaps greater assurance in equipment where there may be any possibility of contact occurring between the refrigerants in liquid form and the lubricant.

Compressors of both the reciprocating and rotary type are used in systems employing these chemicals. In the former the essential principles of splash lubrication are involved. In rotary compressors the lubricant passes through a continuous cycle, passing first to the bearings at each end of the machine and thence via ducts to the bearing compartments. The rotor blades pick it up at this stage and carry it into the cylinders from whence it is discharged with the compressed gas to the condenser and separator. In the latter, the lubricant being the heavier, is separated from the refrigerant. From the separator it is again forced to the compressor to begin the cycle anew. The flow of lubricant is noted by means of the sight feed equipment or bullseyes which are generally installed in the circulating system.

HYDRO-CARBON REFRIGERANTS

In order to effectively lubricate compressors using hydro-carbon refrigerants, a lubricant must be selected that is relatively insoluble in these chemicals. Medium viscosity mineral oils of a high degree of refinement are suitable for such service, as are also certain glycerine blends such as glycol.

SULPHUR DIOXIDE MACHINERY LUBRICATION

Sulphur dioxide is another refrigerant whose machinery requires careful selection of the lubricant. Only the highest grade of mineral oil can be used, for like some other low pressure chemicals, sulphur dioxide has a decided affinity for certain of the hydrocarbon components in mineral lubricants. It is entirely possible to specially treat mineral oils of medium viscosities to remove the component parts affected by sulphur dioxide and render the residual oil quite satisfactory as a lubricant.

In certain household refrigerating systems, provision is made for removal of any lubricant that may have entered the system, by means of a suitable return line. In others, oil traps or separators are employed in much the same manner as in an industrial ammonia or carbonic anhydride system. Location of the evaporator or refrigerating side of the installation on a higher level than the compressor will permit of drainage of the lubricant back to the latter if it is present in either the coils or suction line.

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